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Growing pertinence of bioenergy in formal/informal global energy schemes: Necessity for optimising awareness strategies and increased investments in renewable energy technologies

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ABSTRACT

Biomass, most of which is presently in the form of lignocellulose, is an important source of energy in many developing countries, particularly those in sub-Sahara Africa. The intensity of sourcing and use of these renewable natural resources in these countries are increasing owing to multifarious reasons. Series of reported studies and experiences have shown that this trend is not likely to reverse in the nearest future in these countries and that there is also very likely to be an upward global surge in this regard perhaps because of the expected positive responses to the increasing campaign for gradual energy switch to biofuels partly in order to contribute to the series of efforts at controlling the presently experienced global climate change as a result of fossil fuel combustion on one hand and finiteness of this non-renewable resource (fossil fuel) on the other. In line with these concerns, some developed countries are already increasing biofuels in their energy supplies, main source of which are expected to likely be from less developed tropical countries in future with series of projections concerning this. Therefore, there is the need for sustainable means of producing biomass for this purpose in these developing countries coupled with strategies that will capture future possibilities of supplying this resource to other parts of the world when the demand arise. However, literature showed that irrespective of the increasing importance of biofuels, the present awareness levels concerning this and investment in renewable energy technologies are still low, noting that most of the efforts in these regard appear to be more in the developed countries. Increased awareness and investments in bioenergy is therefore also imperative in developing countries bearing in mind this region's importance in its future sourcing and supply. The concept behind this article is to highlight the growing global importance and usage of biomass energy and their influence on both formal and informal global energy schemes, hoping this will be valuable to the various stakeholders that influence growth and development in this sector, particularly in the developing countries.

Contents

1. Introduction

The significant roles played by energy and associated systems in human development for years have been variously acknowledged from different perspectives. For instance, access to energy have been

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very important in the provision of heat, light, transportation, among others, where and when needed. Similarly, businesses, commerce, industries, public services such as modern health care, education, communication, among others, are also highly dependent on the availability, quantity and quality of energy required. Accordingly, it should be expected that the types and levels of advancement in technologies for energy generation, conversion and use will be among the main determinants of the different levels of “development” worldwide [1–3]. Nevertheless, it is noteworthy that the “quality” of sources and forms of energy is not substantive.

The non-substantive nature of quality of sources and forms of energy entails that different forms of energy cannot be easily substituted for each other or aggregated into an overall index [4]. However, in line with the earlier assertions that are based on informed opinions, establishing direct relationship between the absence of adequate and qualitative energy services and many poverty indicators will logically follow. In a similar manner, experiences have also shown that achieving sustainable development in every part of the world will be a more difficult task if the series of issues concerning sustainable generation and utilisation of energy are not properly conceptualised and executed in ways that will not only enhance sourcing and usage but also the processes surrounding the improvements in research and development concerning them.

Today, the perceived or real disparity among the different parts of the world in terms of “development” is mainly described using level(s) of technological advancement and material well-being. However, it is worth noting that the designations "developed"/ "developing" are mainly intended for convenience and most times do not necessarily express a judgement about the stage reached by a particular country or geographical area in the development process [5] as the levels of development may vary widely within the so-called developing countries, with some of them having high average standards of living [6,7]. Nonetheless, most of geographical entities termed “developing” are currently located in Africa, Asia, Latin America, and the Caribbean regions.

These developing countries, many of which are with lots of renewable natural resources (RNR), are predominantly inhabited by people with average standard of living lower than those of developed countries perhaps because of the disparity in the levels of education and industrialisation between these two described entities. Paradoxically, most of these developed countries are with comparatively lesser RNR. This lend credence to the assertion by Erakhrumen [8] that neither lack nor availability of RNR determines the poverty or affluence status of any country but lack or availability of appropriate and adequate human resources to develop and make use of science and technology in adding value to these RNR and also to attract investments. This appears to be the case in all facets of life including energy and associated systems related to development worldwide.

For instance, the principal means of generating energy earlier known to mankind was the combustion of biomass, whose use later declined significantly in industrialised countries, owing to the discovery and subsequent large-scale use of fossil fuels. This switch, understandably, resulted from the realisation that energy density of fossil fuels is comparatively higher than that for biomass coupled with the claim that there is the need for a lot of energy to collect biomass for biofuel. In addition, biomass is also considered to be bulky when compared to fossil fuels. However, biomass still presently serves as the main source of energy in many developing countries, especially in their rural areas [3,9–14]. This source of energy has been seen as a means of contributing to rural development and job creation, as revenues from biomass and biomass-derived products could provide a key lever for development and enhanced agricultural production in these areas [15].

Similarly, many of the developed countries that are currently largely dependent on fossil derived fuels, with financial resources for this, are also gradually increasing bioenergy in their energy supplies/mix [3,11,12] perhaps partly because biofuel hold out the prospect of replacing substantial volumes of imported oil in the coming decades coupled with other considerations. Therefore, owing to these recent developments and future projections, this article was conceived in order to highlight the increasing importance and usage of biomass energy and their influence on both formal and informal global energy schemes. It is expected that this contribution will be valuable to the various stakeholders that influence growth and development in the energy sector, (in this case biomass energy), most especially in the developing countries.

2. Some salient issues concerning renewable sources of energy

In defining what "renewable sources of energy" are in this article, an attempt is made by applying the definitions used in the United Nations system and that by European Parliament and Council. Renewable sources of energy was defined as large- and small-scale hydropower, modern and traditional biomass energy, solar energy, wind energy, ocean energy, urban and rural organic waste, and geothermal energy [16]. Similarly, the directive 2009/ 28/EC of the European Parliament and Council under article 2 considered the earlier mentioned energy sources, including aerothermal, hydrothermal, landfill gas, sewage treatment plant gas and biogas to be energy from “renewable sources”. However, documented reports showed that large-scale hydropower and traditional biomass are the most important among these in terms of application for energy generation.

Interests in issues concerning renewable energy (RE) are gradually increasing worldwide, however, another paradox is that research and development efforts concerning them presently appear to be more and are also increasing in developed countries in comparison with other parts of the world, particularly the developing countries, where biomass still serves as the main source of energy [2]. This growing interest in RE, and in biomass energy particularly, might not be unconnected with the fact that the current energy system is unsustainable, as fossil fuels are finite, thus, making it better to start early looking for sustainable alternatives [2,17].

Presently, the demand for energy in the developing countries is rising rapidly and acute shortage could be a bottleneck to economic and social development [3,18,19]. This is partly the reason why some current opinions have it that while many developing countries will aim at reducing dependence on traditional bioenergy fuels as part of policies to improve access to modern energy services, the global trend is expected to focus on how to increase the share of modern bioenergy in the global energy mix [20]. In addition, security of energy supply is a global issue that elicit series of national and international policies. For instance, a large proportion of known conventional oil and gas reserves are concentrated in politically unstable regions of the world [15].

This implies that increasing the diversity in energy sources is important for many nations to secure a reliable and constant supply of energy [15]. Biomass use for the production of heat and other types of energy is also seen to possess potentials for carbon neutrality when considering climate change mitigation [21], as biomass, when grown and converted for this purpose in a closed-loop feedstock production scheme, generates no net carbon dioxide (CO_2) emission, thereby, claiming a neutral position in the build-up of atmospheric greenhouse gases (GHGs) [2,22]. This, in line with certain opinions, simply means that when biomass,

containing carbon fixed from CO_2 in the air is burned, the net amount of atmospheric CO_2 remains the same.

However, there are differing opinions concerning the maintenance of atmospheric carbon neutrality when using biomass as fuel. In disagreeing with this position, Schlamadinger et al. [10] opined that the assumption that biomass energy is a carbon neutral source is rarely precisely true. They went ahead to buttress this point by stating that biomass energy projects that extract carbon from existing forests tend to somewhat reduce the carbon stocks and can therefore, temporarily, constitute a net source. Furthermore, projects that involve establishing new crops on previously unforested lands will generally involve carbon accumulation for some period – in the case of wood-based crops, several years – before combustion; and the equilibrium level of above-ground carbon stock may be substantially different from that without such activity [10].

In addition, several forms of biomass energy may result in changes in soil carbon (positive or negative) potentially over long periods [10]. In any case, whichever argument is being advanced by the different stakeholders, it is beyond the scope of this article to validate or invalidate any. However, what is of importance here is that there is the need for increase awareness and investments efforts concerning bioenergy generation, utilisation and related issues worldwide. Thus, there is urgent need for criteria that will ensure sustainable production of biomass [23]. These efforts are important in view of the earlier mentioned reasons and the current situation whereby bioenergy is not given the importance it deserves generally and particularly in policy and developmental issues, most especially in the developing regions of the world.

This is not only limited to energy generated from biomass, as investments in RE fell proportionally more than in other types of power generations in late 2008 and early 2009, according to the account of IEA [24]. This is partly because comparatively lower fossil fuel prices are undermining the attractiveness of investments in most clean energy technologies [17], i.e., mostly those based on renewable sources of energy. Thus, one of the major challenges concerning renewable energy is to get them into a reliable market at a price which is competitive with energy derived from fossil fuel, and without disrupting the local economies [25].

3. Increasing application of biomass for the generation of energy

Biomass, in the context of this article, is defined in basic terms as organic material from recently living things. It simply means the biodegradable fraction from biological origins that include agriculture (including vegetal and animal substances), forestry and related industries, fisheries and aquaculture as well as the biodegradable fraction of industrial and municipal waste. In this kind of discussion, plant matter from trees and other woody species, grasses, agricultural and other crops, are very pertinent. Plant biomass is composed primarily of carbon, oxygen and moisture, including other substances, in the form of varying amounts of cellulose, hemicellulose, lignin and a small amount of other extractives such as sulphur, ash, among others.

When the chemical bonds between adjacent carbon, hydrogen and oxygen molecules are broken by digestion, combustion, or decomposition, these biomass substances release their stored chemical energy that combines with oxygen to produce CO_2. The CO_2 is again available to produce new biomass, in a cyclical manner, noting that the chemistry behind these processes is complex and variable. As a source of energy, biomass that contributes about 10% is the world's fourth largest resource after the fossil fuels (oil, gas and coal). Currently, these fossil fuels together make up about 81% of the world's energy demand [26]. As earlier stated, these fossil fuels are finite and not renewable but bioenergy is however, considered renewable since biomass can be continuously produced in sustainable ways if proper supporting strategies are put in place.

Plant biomass for energy can include products, waste and residues from agriculture, forestry, and the wood processing industry, as well as biomass produced from degraded and marginal lands. It may also be produced on good quality agricultural and pasture lands without jeopardising the world's food and feed supply if agricultural land use efficiency is increased, especially in developing regions. Bioenergy production can also be a way to rehabilitate marginal and degraded land thereby bringing it back into profitable use. This will most likely only happen, however, if it is supported by appropriate policy. Without such policy, there is a danger that bioenergy producers will seek good land, where yields are higher, and so compete directly with food production [20].

Meanwhile, Table 1 gives an overview of the global potential of biomass for energy (EJ per year) to 2050 for a number of categories and the main preconditions and assumptions that determine these potentials [15]. Currently, RE accounted for about 13.3% of the world's total primary energy [11] and it is believed that it will play an increasingly important role in energy supplies in both developing and developed societies in the future [3,19,27].

Biofuels, according to available records, amounted to almost 80% of the total RE, supplying more energy than nuclear sources, and about four times as much as hydropower, wind, solar and geothermal energy combined. It was earlier estimated that bioenergy could provide 15% of the world's primary energy use, although, a wide diversity of projections of potential future energy demand and supply exist in literature [31]. It is however clear that biomass can make a very large contribution to the world's future energy supply. This contribution could range from 20% to 50% [15] with about 75% of global biofuels estimated to be derived from wood fuel (fuelwood, charcoal and black liquor). For example, in the case of wood fuel, expectations for future increases in its global demand have been earlier buttressed by series of estimations.

For instance, Broadhead et al. [32] estimated a global wood fuel production that will increase moderately from about 1885 million m^3 in 2000 to 1954 million m^3 in 2020. Recent estimates also showed that consumption of wood fuel increased worldwide, for instance, between 2004 and 2006 alone, global consumption increased by 6% [33]. The increasing trend in wood fuel consumption has been predicted to continue in this manner in the foreseeable future [11]. In addition, the increasing trend in the use of biomass energy in many developed countries like those of Organization for Economic Cooperation and Development, such as Austria, Finland, Germany, Sweden, among others, is also particularly noteworthy in this regard.

In the past decade, the number of countries exploiting biomass opportunities for the provision of energy has increased rapidly. The global use of biomass for energy increases continuously and has doubled in the last 40 years [34]. Based on these observations, it can be stated that bioenergy may be the most important RE source in the near- and medium-term future. It will therefore play a crucial role in integrated systems of future energy supply and will be a valuable element of a new energy mix [34]. As an illustration, Table 2 shows the estimated future world demand for bioenergy from wood up to the year 2040 with most of the projected demand expectedly needed for domestic and commercial purposes.

Furthermore, it is considered important to add that estimations have it that about 60% of the biomass used for energy generation is through direct combustion, particularly in the developing countries, in line with the prevalent socio-cultural and economic realities including the present level of conversion technologies,

Table 1
Overview of the global potential of biomass for energy (EJ per year) to 2050 for a number of categories and the main preconditions and assumptions that determine these potentials.
Source: IEA [15] based on Berndes [28]; Hoogwijk [29]; Smeets [30].

Biomass category	*Main assumptions and remarks*	*Energy potential in biomass up to 2050*
Energy farming on current agricultural land	Potential land surplus: 0–4 Gha (average: 1–2 Gha). A large surplus requires structural adaptation towards more efficient agricultural production systems. When this is not feasible, the bioenergy potential could be reduced to zero. On average higher yields are likely because of better soil quality: 8–12 dry tonne/ha/yr* is assumed	0–700 EJ (more average development: 100–300 EJ)
Biomass production on marginal lands	On a global scale a maximum land surface of 1.7 Gha could be involved. Low productivity of 2–5 dry tonne/ha/yr.* The net supplies could be low due to poor economics or competition with food production	$<$ 60–110 EJ
Residues from agriculture	Potential depends on yield/product ratios and the total agricultural land area as well as type of production system. Extensive production systems require re-use of residues for maintaining soil fertility. Intensive systems allow for higher utilisation rates of residues	15–70 EJ
Forest residues	The sustainable energy potential of the world's forests is unclear—some natural forests are protected. Low value: includes limitations with respect to logistics and strict standards for removal of forest material. High value: technical potential. Figures include processing residues	30–150 EJ
Dung	Use of dried dung. Low estimate based on global current use. High estimate: technical potential. Utilisation (collection) in the longer term is uncertain	5–55 EJ
Organic wastes	Estimate on basis of literature values. Strongly dependent on economic development, consumption and the use of bio-materials. Figures include the organic fraction of municipal solid waste and waste wood. Higher values possible by more intensive use of bio-materials	5–50 EJ
Combined potential	Most pessimistic scenario: no land available for energy farming; only utilisation of residues. Most optimistic scenario: intensive agriculture concentrated on the better quality soils. In parentheses: average potential in a world aiming for large-scale deployment of bioenergy	40–1100 EJ (200–400 EJ)

* Heating value: 19 GJ/tonne dry matter.

Table 2
Estimated future world demand for wood fuel up to the year 2040.
Source: Adapted from ITTO [35].

Projected year	*2020*	*2030*	*2040*
Fuelwood total (10^9 m^3)	1.7	1.8	1.9
Domestic and commercial (10^9 m^3)	1.5	1.5	1.4
Industrial bioenergy (10^9 m^3)	0.2	0.3	0.5

although, a few percent is for more advanced uses, such as creating liquid or gaseous fuels mainly in technologically advanced countries. These direct methods of combustion are mostly in inefficient stoves and burners and are almost entirely considered an ecologically unacceptable solution in the long range. Further discussion of efficiencies and environmental impacts of biomass combustion can be found in the literature, e.g., Sørensen [36].

In addition, the bulk of liquid biofuels is in the form of ethanol and diesters—commonly referred to as biodiesel. Ethanol is usually produced from starchy crops, such as cereals and sugar, while biodiesel is produced mainly from oil-seed crops, including rape-seed and sunflowers. Global fuel ethanol production more than doubled between 2000 and 2005, while production of biodiesel, starting from a much smaller base, expanded nearly four-fold [37]. Global production of biofuels amounted to just under 26 million tonnes of oil equivalent, or 840 thousand barrels per day in 2005—equal to 1% of total road-transport fuel consumption in energy terms with Brazil and the United States together accounting for about 70% of global supply [38].

For instance, Brazil, in 2004 and 2005, exported about 2.5 billion litres of ethanol mainly about 23.1% and 20.2% of this amount to India and the United States respectively [39]. In the medium term, ethanol and high-quality synthetic fuels from woody biomass are expected to be competitive at crude oil prices above US $45 per barrel [15]. Additionally, the biodiesel production in the United States that was 1.9 million litres as at 1995 increased to more than 280 million litres by 2005 [37]. The Indian and Chinese demand for plant oils considerably increased since year 2000. For example, China is currently importing about 45% of rape grains traded world wide instead of about 10% ten years earlier, i.e., around the year 2000 [17] with reports showing an increment in this volume in recent years.

4. Incorporating bioenergy-related policies into global energy schemes

Global energy demand is growing rapidly with about 88% of this demand being met by fossil fuels. This demand is expected to at least double or perhaps triple during this century [15]. However, available records in the literature have it that there is an increase in both the use of biomass as main energy source in less advanced countries and incorporation of this type of energy source into energy supplies in advanced countries, irrespective of the reality in some places that most biofuels programmes were earlier conceived as part of farm-support policies. It is even estimated that by 2050 sustainable sources of biomass could be enough to supply the world with 10–20% of its primary energy requirements [26].

A growing number of governments are now looking at expanding or introducing programmes for genuine energy-security, economic and environmental reasons, thus, they are developing, adopting and/or adapting strategies/schemes that will take care of this development, as the success of an emerging industry or application requires government support, thus, the influence of government policies concerning most natural resources cannot be overemphasised. Biomass and bioenergy are now a key option in energy policies. Security of supply, an alternative for mineral oil and reduced carbon emissions are key reasons. Targets and expectations for bioenergy in many national policies are ambitious, reaching 20–30% of total energy demand in various countries. Similarly, long-term energy scenarios also contain some challenging targets [15].

For instance, the United States recently enacted Renewable Fuels Standard, which will require the use of 28.4 billion litres (7.5

billion gallons) of biofuels for transportation in the country by 2012. Production of bio-ethanol in the United States has surged in recent years as a result of tax incentives and rising demand for ethanol as a gasoline-blending component. Many United States government fleet vehicles that run on diesel fuel are now required to use B20 blends under new guidelines implementing the Energy Policy Act of 1992. In the same vein, Canadian government also want increased percentage of ethanol in the country's gasoline consumption with Ontario being the main hub of ethanol programme. Many in the industry believe that these targets represent a floor, rather than a limit, to biofuel production [38].

Similarly, production of biofuels in Europe is growing rapidly owing to strong government incentives. More than half of European Union (EU) production is biodiesel, which in turn makes up almost 87% of world biodiesel output. Under the EU Common Agricultural Policy and a trade agreement with the United States, set-aside land – farm land left fallow for which farmers are paid a per-hectare subsidy under a scheme to reduce surplus output – can be used to grow crops for biofuels up to a limit of 1 million tonnes of soybean equivalent per year. In addition, biodiesel enjoys a minimum tax exemption of 90% of that on conventional diesel. Some countries, including Germany, levy no excise tax at all on biodiesel. Several countries also provide financial incentives for investment in bio-refineries.

In 2003, the EU adopted a directive requiring all member states to set non-binding national targets for a minimum share of biofuels in the overall transport-fuel market. The target was 2% for end-2005, rising to 5.75% by end-2010. In fact, the share reached only about 1.4% in 2005, although it was well up on the level of 0.6% in 2003 [38]. For example, the Netherlands accepted the objectives of the Biofuels Directive of the European Commission and agreed to replace part of road transport fuels by biofuels. The Platform Groene Grondstoffen, part of the Energy Transition of the Netherlands proposed to replace 60% the road transport fuels by biofuels after 2030 [40] as quoted in Faaij [38].

Similarly in the UK, the Renewables Obligation was earlier adopted in 2000 [41] and it is the current main mechanism for supporting large scale generation of renewable electricity in the country. It has been subjected to various reforms and improvements since 2002, with the most significant one being in April 2009, with the introduction of banding, giving different technologies different levels of support. In April 2010, the end date for support was extended to 2037 or 20 years (whichever is the earlier) for new projects. In addition, following the adoption of a carbon tax in Sweden in 1990, the annual use of forest residues in district heating began to rise rapidly [42].

These kinds of increase usage and recommendation of biomass for this purpose might have influenced EU's efforts at working towards sustainability through her Renewable Energy Directive. This directive states, in part, that “an increase in the use of biofuels should be accompanied by a detailed analysis of the environmental, economic, and social impact in order to decide whether it is advisable to increase the proportion of biofuels in relation to conventional fuels”. In 2010, the European Commission published its recommendations for sustainability criteria to promote the sustainable production and use of biomass. A minimum GHG saving of 35%, rising to 50% from 1 January 2017 and 60% from 1 January 2018, against a fossil fuel comparator has been suggested for the production of electricity.

Further, the Taiwanese cabinet also officially passed the “Renewable Energy Development Act” in June 2005. The Act assigns designated prices for the purchase of electricity produced by RE schemes and the duration of guaranteed purchase. This Act declares that the total power generated by RE measures will account for 12% of overall output; where high costs are required for RE power generation, the government will provide financial support. In Japan, the government has permitted low-level ethanol blends in preparation for a possible blending mandate, with a long-term intention of replacing 20% of the nation's oil demand with biofuels or gas-to-liquid fuels by 2030. Chinese and Indian planners have also sought to expand the national supply of ethanol and biodiesel [38].

Thailand, also eager to reduce the cost of oil imports while supporting domestic sugar and cassava growers, mandated an ambitious 10% ethanol mix in gasoline starting in 2007. Similar efforts concerning ethanol and biodiesel exist in Philippines, Malaysia and Indonesia. The Brazilian government also want to build on the success of earlier ethanol programme expanding the production of biodiesel. It is expected that all diesel fuel should contain 5% biodiesel by 2013, hoping to ensure that poor farmers in the north and northeast receive much of the economic benefits of biodiesel production. Columbia, Venezuela, Bolivia, Costa Rica, Guatemala, Argentina, Mexico, Paraguay, and Peru are all considering new biofuel programs as well. Brazil, as the world's leader in fuel ethanol, has helped many of these and other countries learn from its examples [38].

One of such Brazilian examples is the large scale bioenergy programme, known as PRO-ALCOOL, which was launched in 1975 as a response to the oil crises. Through this programme ethanol from sugar cane bagasse has been used as a transport fuel. In spite of mixed economic results, it has been considered a technical success, and has provided both social and environmental benefits. The efficiency of many of these biomass energy schemes may have been traditionally low in the past but there are efforts geared towards increasing them. For example, recent progress has indicated scope for bringing the price of liquid biofuels from residues down from the present cost of nearly twice that of diesel oil. The production from food material, such as the Brazilian ethanol made from sugar, has as a result of experience and scale of production, reached prices similar to or even lower than those of conventional fuels [43].

For example, the cost of producing the ethanol is equivalent to an oil price of around US $30 per barrel. When oil prices are below this level, the country must pay to produce fuel that could be imported more cheaply as oil. The beneficial effects of lowering imports by US $20–30 billion, creating (directly and indirectly) almost a million jobs, cutting air pollution in urban areas and reducing energy-related carbon emissions by 15–20% can be offset against this [20]. In the United States, where ethanol has been used as a minor additive to gasoline, the view is that production from grain will not become competitive, but that production from cellulosic residues may have that potential [44]. This potential is being increasingly highlighted in the literature [3,19].

5. Concluding remarks

Presently, renewable energy appears to mean differently thereby serving varied purposes for the various stakeholders worldwide. For instance, the application of biomass in the generation of energy is important to different users in a variety of ways. While the prevalent local socio-economic and other indigenous/traditional considerations might govern this use in some places, issues surrounding environmental and energy sustainability might be the ones governing it in other climes. Irrespective of these, the rate and intensity of bioenergy usage worldwide are continuously increasing to the extent that it is currently influencing both formal and informal energy schemes.

It may be easy to take this for granted in most developing countries as their inhabitants are predominantly dependent on this type of energy source, however, record currently shows that efforts toward formulation and implementation of policies

including scientific and technological improvements in this regard are comparatively more in developed countries. In addition, the challenges earlier highlighted in developing countries presently appear to be particularly more in Africa as most of the countries on this continent seemingly lack coherent policy including sufficient intense scientific and technological approach appropriate for surmounting these challenges.

Meanwhile, reports have it that efforts to expand biofuels production and use are being initiated or are underway in some countries like Kenya, Malawi, Zimbabwe, Ghana, Ethiopia, Benin, Mozambique, Senegal, Guinea Bissau, Ethiopia, Nigeria, and South Africa. These efforts are presently limited and far from the expected level considering the potential role these and other countries in Africa are likely to play concerning sourcing and supply of bioenergy for consumption both for local and export in the future as series of projections have shown that sustenance of future global bioenergy use is likely to be hinged on sustainability in these and other tropical countries.

Therefore, the developing countries, most especially those in sub-Sahara Africa, must not only fast track the development of their renewable energy policies in line with local realities but are also to be acquainted with the current global paradigm in this regard. These policies are to be aimed at sustainability in the management of renewable resources taking into consideration local and external influences. In addition, being in touch with current happenings in other parts of the world as it concerns renewable energy will likely assist local scenarios as solutions to similar challenges that have been surmounted in these other climes may be adopted and/or adapted locally.

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